Welders and Related Machine Operators
Occupational Exposure Summary Package

This package serves as a summary of CAREX Canada’s results on the known or suspected carcinogens that welders and related machine operators in Canada are exposed to at work. Assembling various CAREX Canada data, tools, and resources, it provides an overview of the most prevalent exposures for the occupation, including artificial ultraviolet radiation, lead, nickel, hexavalent chromium, and cadmium. Our aim is to provide a useful guide for those looking to better understand – and help reduce or eliminate – common carcinogenic exposures associated with welding and related machine operating.

Welders and related machine operators in Canada

There are 103,000 welders in Canada, according to the 2006 Canadian census. Welders are defined herein as workers operating welding equipment to weld or join together ferrous and non-ferrous metals. Those who operate production welding, brazing, and soldering equipment are also included in this classification. Although other occupations, such as contractors in metal forming, mechanics, machinists, plumbers, pipefitters, and other metal workers, may also weld as part of their job, they are not included within this classification. Welders and related machine operators will be referred to simply as welders for the remainder of this report, unless otherwise stated.

Estimates of prevalent exposures

CAREX Canada estimates of the number of welders exposed to carcinogens at work are summarized in Figure 1. Artificial ultraviolet radiation (UVR), inorganic lead compounds, nickel compounds, and hexavalent chromium compounds are the most prevalent among welders. These exposures are most likely to occur in the following sectors: commercial and industrial machinery and equipment repair and maintenance, architectural and structural metals manufacturing, and agricultural, construction and mining machinery manufacturing. Exposure level estimates, where available, are summarized in the Carcinogen Profiles below.

Figure 1: Top 10 prevalent carcinogen exposures for welders and related machine operators, CAREX Canada Database, 2006

Note: High prevalence does not necessarily indicate a high cancer risk. For more information or assistance interpreting the data in this table, please contact us at info@carexcanada.ca.

We classify carcinogens based on evaluations made by the International Agency for Research on Cancer (IARC). Most of the agents listed in Figure 1 are classified as known carcinogens (IARC 1), where there is sufficient evidence linking the agent with cancer in humans.
Our eWORK Tool allows users to explore CAREX exposure data by carcinogen, sector, occupation, province, sex, and exposure level. We offer two versions of the eWORK Tool: eWORK Excel and eWORK Online. eWORK Excel uses a Microsoft Excel PowerPivot interface that allows users to search for – and visualize – exposures of interest. eWORK Online is for users who prefer quick, accessible, yet high-quality statistics on occupational exposures to various carcinogens.

eWORK Excel and eWORK Online are available under the Tools tab of our website.

Carcinogen profiles

The CAREX Canada website contains detailed information on use, production and trade, exposure routes, and health effects for the top ten carcinogen exposures for welders listed above. A sample of these are summarized below.

More information, including regulations and guidelines for each agent, methods for calculating exposure level estimates, and a list of references, is available under the Profiles and Estimates tab of our website.

Artificial Ultraviolet Radiation

Known Carcinogen (IARC 1)

What is artificial ultraviolet radiation?

Ultraviolet radiation (UVR) is a type of radiation found between visible light and x-rays on the electromagnetic spectrum. Artificial sources of UVR emit a range of wavelengths specific to each source; these include welding arcs and UV lasers.

What are the main sources of artificial ultraviolet radiation in welding?

Electric welding arcs can produce significant levels of UVR within a radius of several metres; gas welding and cutting torches do not produce high levels of UVR.

Occupational exposure to artificial ultraviolet radiation

Occupational exposure to artificial UVR occurs via skin and eye exposure. Welders are the largest occupational group exposed to artificial UVR.

What are its health effects?

Cancer:
Artificial UVR exposure is associated with skin and ocular melanoma. There is sufficient evidence for ocular melanoma in welders.

Non-cancer:
Exposure to UVR may result in short term skin damage such as burning, fragility, and scarring. Welders are at risk of “arc flash”, an injury to the surface and mucous membrane (conjunctiva) of the eye.
Carcinogenic Exposures
Welders and Related Machine Operators

What is lead?
Elemental lead is a soft, highly malleable and ductile metal that is insoluble in water. Lead forms both inorganic and organic compounds with many substances, including acetate, arsenic, antimony, chlorine, oxygen, and phosphate.

What are the main sources of lead in welding occupations?
The main source of lead exposure in welders is solder, brass, and bronze alloys, and primer or coating on steels, according to the Canadian Centre for Occupational Health and Safety (CCOHS). Lead oxide, or red lead, is the primary paint primer for iron and steel.

Occupational exposure to lead
Inhalation of welding fumes is the most important route of occupational exposure, followed by ingestion. The largest occupational groups exposed to lead include welders and police officers.

What are the health effects of lead?

Cancer:
IARC has classified inorganic lead compounds as probably carcinogenic to humans and elemental lead as possibly carcinogenic to humans, while organic lead compounds were not classifiable. Increases in cancer of the lung, stomach, kidney, brain and nervous system have been observed in humans following exposure to inorganic lead compounds.

Non-cancer:
Fetal and childhood lead exposure can cause a variety of health effects, including anemia, learning disorders, and behavioural problems. Adult exposure to lead can also result in adverse effects on the neurological, cardiovascular, and hematological (blood) systems. Reproductive effects, including miscarriage and pre-term delivery in women, and decreased fertility in men are also associated with moderately high levels of lead exposure.

Nickel
Multiple Classifications (Nickel Compounds: IARC 1 (Known Carcinogen), Metallic Nickel: IARC 2B (Possible Carcinogen))

What is nickel?
Metallic nickel is a silvery, hard metal or a gray powder not commonly found in nature. It typically exists as a trace constituent in minerals, particularly those containing magnesium and iron. Nickel's properties of corrosion, heat resistance, hardness, and strength make it an ideal component of alloys.

What are the main sources of nickel in welding occupations?
Nickel is largely used in stainless steel production, nickel-based alloys, electroplating, and casting and alloy steels. The main source of nickel exposure in welders is stainless steel, high-alloy materials, welding rods, and plated steel, according to the CCOHS.

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Hexavalent Chromium
Known Carcinogen (IARC 1)

What are hexavalent chromium compounds?
Hexavalent chromium compounds are most often products of industrial processes. Canada has not mined chromium ores since the early 1900s, although there are deposits across the country. Recent exploration has taken place in Manitoba, Quebec, and Newfoundland.

What are the main sources of hexavalent chromium compounds in welding occupations?
Hexavalent chromium is used to manufacture stainless steel and other alloys, pigments, wood preservatives, and to finish metal (chrome plating). Key sources of exposure in welders include most stainless steel and high-alloy materials, welding rods, and plating material, according to the Canadian Centre for Occupational Health And Safety (CCOHS).

Occupational exposure to hexavalent chromium compounds
Inhalation and dermal contact are the most important routes of occupational exposure to hexavalent chromium. When examining exposure by occupation, the largest exposed group is welders.

What are its health effects?
Cancer:
There is a well-established link between hexavalent chromium and lung cancer. Several epidemiological studies have also found increased risks of cancer in the nasal region.

Non-cancer:
Acute inhalation exposure to hexavalent chromium may irritate and damage the nose, throat and lungs. Dermal exposure may also cause allergic contact dermatitis and sensitize the skin.

Welders and Related Machine Operators
Carcinogenic Exposures
# Cadmium
Known Carcinogen (IARC 1)

## What is cadmium?
Cadmium is a **soft, silver-white or blue, lustrous metal** typically found in mineral deposits with lead, zinc, and copper.

## What are the main sources of cadmium in welding occupations?
Cadmium is used in alloys, solar cells and semiconductors, as well as for corrosion resistance in coatings for electronics, steel, and aluminum. The main source of cadmium oxide exposure in welders according to the CCOHS is **stainless steel containing cadmium or plated materials and zinc alloy**.

## Occupational exposure to cadmium
Inhalation and ingestion are main routes of occupational exposure to cadmium. Occupations with high potential of exposure include those involved in producing and processing zinc, lead, and steel, coating and plating cadmium, machining and welding cadmium-coated steel, and manufacturing cadmium-nickel batteries. **Welders are the largest occupational group exposed** to cadmium.

## What are its health effects?

<table>
<thead>
<tr>
<th>Cancer:</th>
<th>Non-cancer:</th>
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<td>Evidence of the carcinogenicity of cadmium is sufficient in humans and animals. Epidemiological studies show consistent evidence that cadmium workers are at increased risk of lung cancer. Other studies suggest elevated risks of prostate, kidney, and bladder cancers.</td>
<td>Acute inhalation of cadmium at high concentrations affects the lungs, causing severe damage and possibly death. Chronic inhalation at low concentrations can result in cadmium accumulation in the kidneys and possible kidney disease. Chronic ingestion at low levels can result in kidney damage and bone effects.</td>
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Exposure reduction strategies

As outlined by the Canadian Centre for Occupational Health and Safety (CCOHS), a variety of strategies can help protect workers from exposures to harmful substances such as carcinogens. These strategies are listed in order of effectiveness in controlling a risk.

- **Elimination**
  - is the most effective way to control a risk; it involves removing the hazard from the workplace. This process may also involve substitution.
  - *An example of substitution is using lead-free paints and glazes instead of those that contain lead.*

- **Engineering controls**
  - minimize risk of exposure through strategic designs or modifications, which include process controls, enclosure/isolation of the source, and ventilation.
  - *An example of a process control is using wet methods instead of dry when grinding or drilling to reduce dust.*

- **Administrative controls**
  - alter the way the work is done through rules or policies.
  - *An example of an administrative control is shorter work times in areas where exposure may occur.*

- **Personal protective equipment (PPE)**
  - provides a barrier between the worker and the hazard.
  - *Examples of PPE include respirators, eye protection, face shields, gloves, and footwear.*

For more information on these strategies and which one is appropriate for a situation, please visit the hazard control page of the CCOHS website.

A compilation of exposure reduction resources, including the Canadian Partnership Against Cancer's Prevention Policies Directory and the Canadian Cancer Society’s Cancer Information portal, is available on our website.

**Methods**

The goal of the CAREX Canada project is to estimate Canadians’ potential exposures to known and suspected carcinogens in the workplace, prioritizing agents that are most relevant to Canadians. Estimates of the numbers of workers exposed to these agents are calculated by sector, occupation, province and sex for 2006 (using the 2006 Census of Population, the most recent census that includes detailed information on sector and occupation). Where data are available, levels of exposure expected in Canadian workplaces are also estimated. CAREX Canada’s general approach to producing occupational prevalence and exposure level estimates is summarized in Figure 2.

More information on our methods is available under the Profile and Estimates tab on our website.
Data used in developing the occupational estimates for lead, nickel, hexavalent chromium, and cadmium were collected from several sources, including the Canadian Workplace Exposure Database (CWED), which contains over 10,500 measurements for lead exposure, 4,800 measurements for nickel exposure, 4,400 measurements for hexavalent chromium exposure, and over 2,700 measurements for cadmium exposure. These measurements were collected between 1981 and 2004 in Ontario and British Columbia workplaces. Data for occupational exposures to artificial UV radiation, lead, nickel, hexavalent chromium, and cadmium was also collected from scientific peer reviewed publications that addressed exposure in Canada and the United States, as well as technical reports from governments and international bodies.

More information on data sources is available under the Data Sources and Methods tab for each carcinogen on our website.

Strengths and limitations
One of the key strengths of CAREX Canada’s approach is the transparent, systematic, and scientifically rigorous methods used to develop the estimates of occupational carcinogen exposure. A challenge that we face is a general lack of current occupational exposure data. Since the 1990s, regulatory agencies across Canada have significantly decreased workplace exposure sampling. Varied record retention and archiving policies, as well as reduced accessibility to non-electronic data also limit what is available to CAREX Canada. This lack of data may affect both our estimates of prevalence and levels of exposure, especially when the use of a substance has changed substantially since the 1990s. Another limitation is the lack of information about particular work environments, which can make it difficult to determine appropriate exposure proportions for some occupations and industries. These instances are noted in our documentation.
Relevant publications and reports

IARC Monographs Volume 100C: A Review of Human Carcinogens: Arsenic, Metals, Fibres, and Dusts

IARC Monograph Volume 100D: A Review of Human Carcinogens: Radiation

IARC Monographs Volume 87: Inorganic and Organic Lead Compounds

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